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Metropolitan Sprawl

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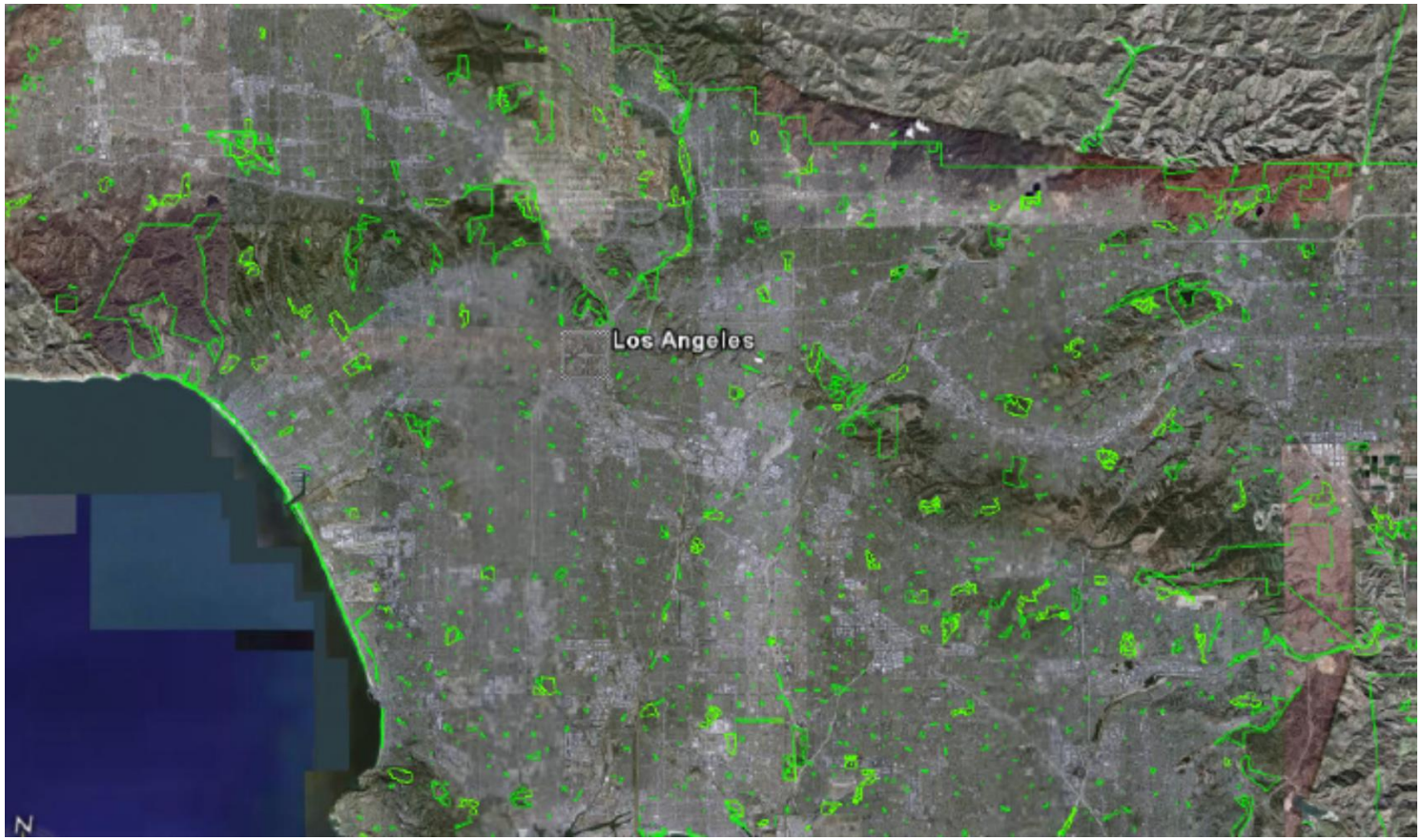
CPSV CENTRE DE POLÍTICA DE SOL I VALORACIONS

Urbanization and Sprawl

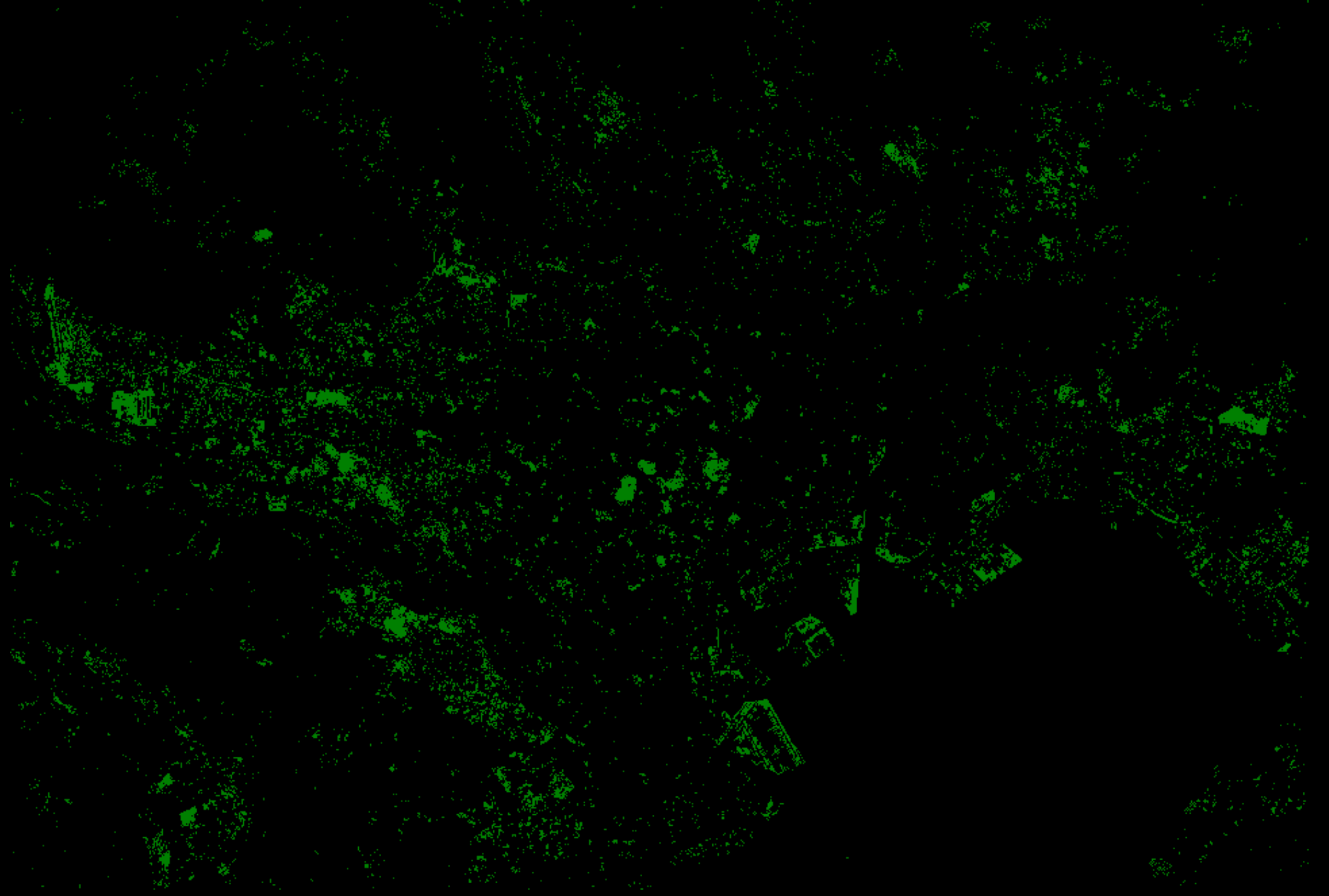
The gradual spread of urbanization, the phenomenon known under the term urban sprawl, has become one of the paradigms that have characterized the urban development since the second half of the twentieth century and early twenty-first century.

Since 1950 there has been a real reversal in the topology of the landscape. Highly artificialized landscapes have gone from "islands" within the "rural ocean" to "colonize" almost the entire planet. The process of urban sprawl has relegated, thus, open spaces to the role of auxiliary elements within the territorial structure.

The green areas in the “urbanized ocean”

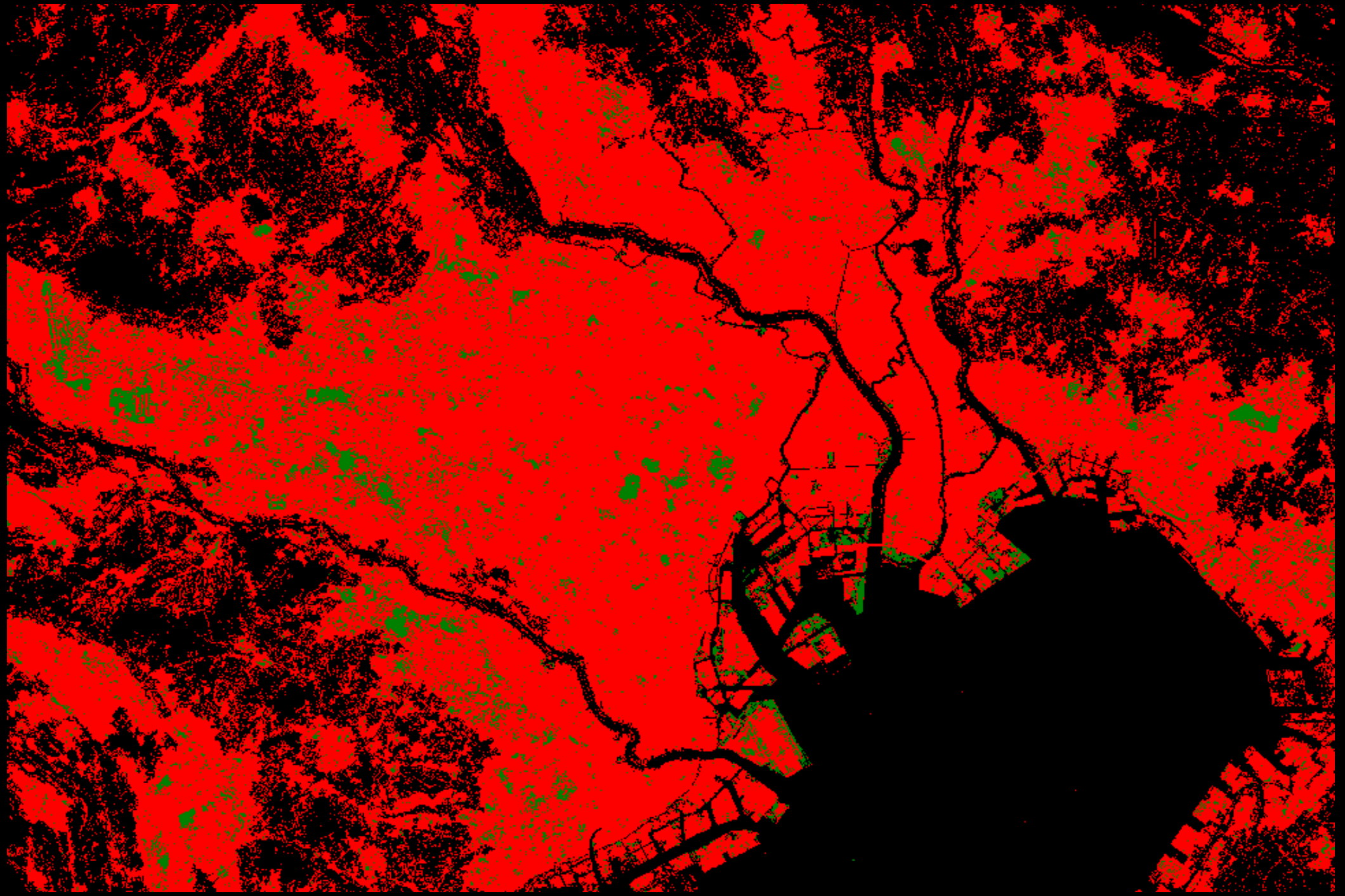


Tokyo: green areas



Source: CPSV-UPC

Tokyo: artificialized land



Source: CPSV-UPC

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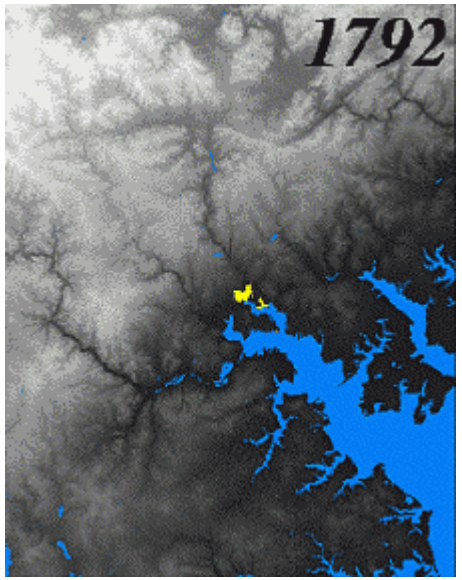
The concept of *urban sprawl*

Sprawl is the spreading out of a city and its suburbs over more and more rural land at the periphery of an urban area. This involves the conversion of open space (rural land) into built-up, developed land over time.

"Sprawl" is an elusive term. Most people can't define sprawl but they know it when they see it.
To some, it means a pattern of auto-oriented suburban development.
To others, it means low-density residential subdivisions on the metropolitan fringe.



Reconstruction of urban growth in Baltimore

The European Environment Agency **(EEA)** has described sprawl as the physical pattern of low-density expansion of large urban areas, under market conditions, mainly into the surrounding agricultural areas. Sprawl is the leading edge of urban growth and implies little planning control of land subdivision. Development is patchy, scattered and strung out, with a tendency for discontinuity.

Sprawl is occurring when, as in most metro areas, suburban expansion consumes land at a faster rate than population grows, even as central cities and inner suburbs decline. .

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Sprawl is defined as a condition of land use that is represented by **low values** on one or more of eight distinct dimensions of land use patterns: density, continuity, concentration, clustering, centrality, nuclearity, mixed uses, and proximity (Galster et alt., 2001).

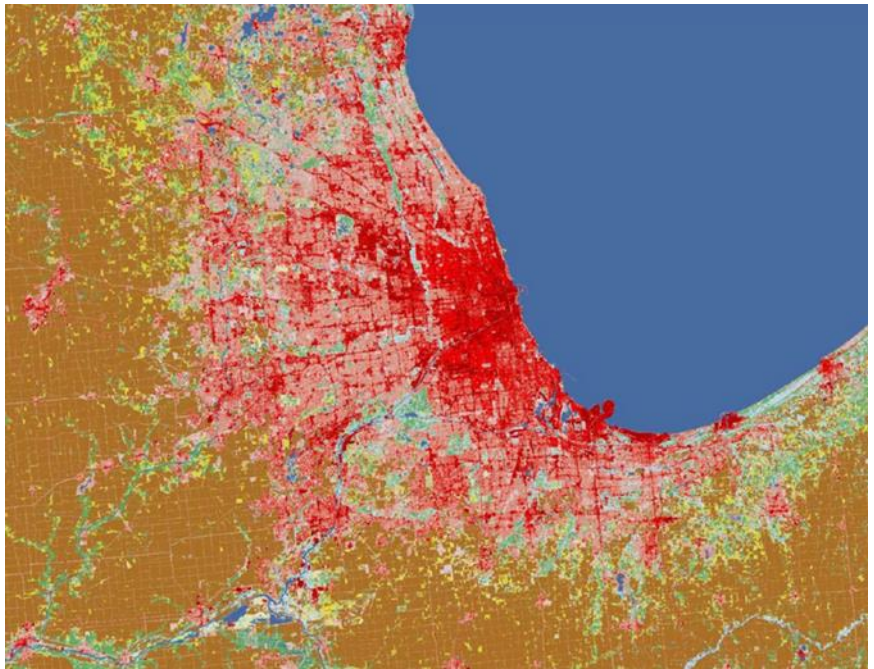


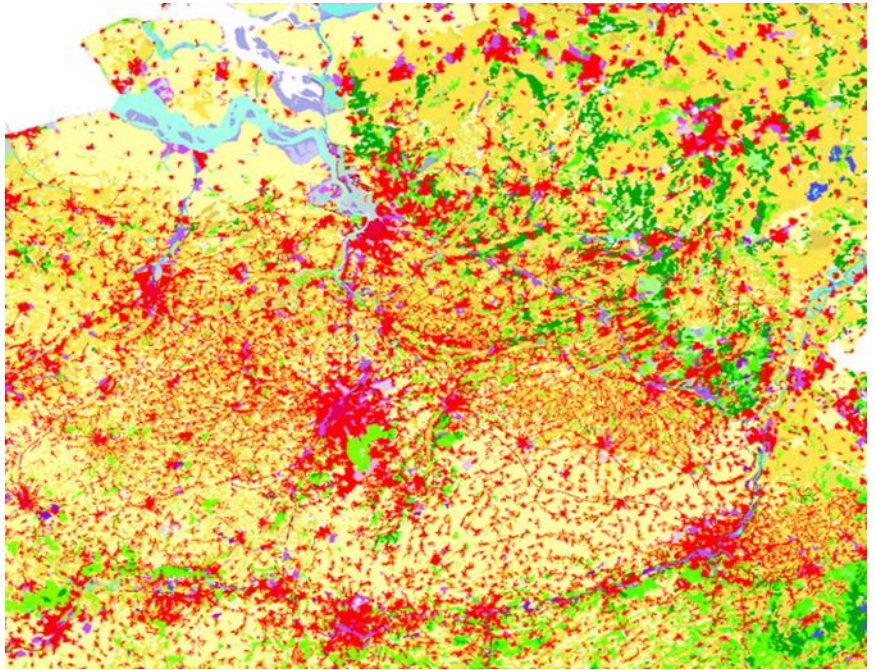



Urbanization and Sprawl

There is no global database that allows comparative studies about urban sprawl between cities or metropolitan areas.

Although remote sensing technology enables the uniform analysis of land consumption at worldwide scale, the diversity of methodologies used and the high cost of required computing has led to the proliferation of scoping studies Local, but have not enabled the generation of an integrated database a planetary scale. An example of this, is the disparity between the analysis of "urbanized covers" produced by agencies of the USA (USGS) and the EU (CORINE LAND COVER).





Objective of the Research

This paper proposes a new methodology to measure the phenomenon of urban sprawl worldwide based on the analysis of the night lights satellite image

The night lights have been used in widespread scientific contributions, from building human development indices (Elvidge et alt, 2012) to identify megalopolis (Florida et alt, 2008 and Arellano & Roca, 2014). However it has not been extensively used to analyze the phenomenon of urban sprawl. In this sense, this paper proposes a new methodology to study the impact of urbanization in the world, especially in metropolitan areas

The research has three key research questions:

How to define the metropolis?
How to differentiate the centers from peripheries?
How to measure urban sprawl?

Our hypothesis is that metropolitan peripheries consume more land per capita than others types of urban agglomerations and therefore where the urban sprawl is more pronounced

1. How to identify Metropolitan Areas?

The overflow of administrative boundaries by urbanization has led to overcoming the old concept of the city and its replacement by others that have tried to understand the new territorial phenomenom. Metropolitan and micropolitan areas, agglomerations, conurbations, daily urban systems, local labor market, functional urban regions, megalopolis, mega-city regions have been, among others, concepts that have tried to replace the "outdated" notion of city

Since 1910 the Census Bureau of the USA regulate metropolitan districts, there have been so many efforts to define and delineate the new artifacts that have come to replace our old and beloved cities. Morphologic (urban continuity), demographic (density based), economic (economic structure) and functional (based on residence / work relationship) criteria has been used to identify metropolises

Although functional boundaries have been, since its adoption in 1960 by the Census Bureau to define the American metropolitan areas, the most widespread and used over the past decades, there isn’t an international standard to define metropolitan areas

Methodology used to identify the Metropolitan Areas

The study assumes that night lights satellite imagery provides valuable information for the identification of urban and metropolitan systems.

For this purpose, we develop a methodology to detect the Highly Impacted Areas from the analysis of existing patterns of urbanization (UA) in the USA and delimitating the metropolitan areas by analyzing the image of night lights called Black Marble (NASA,2013).

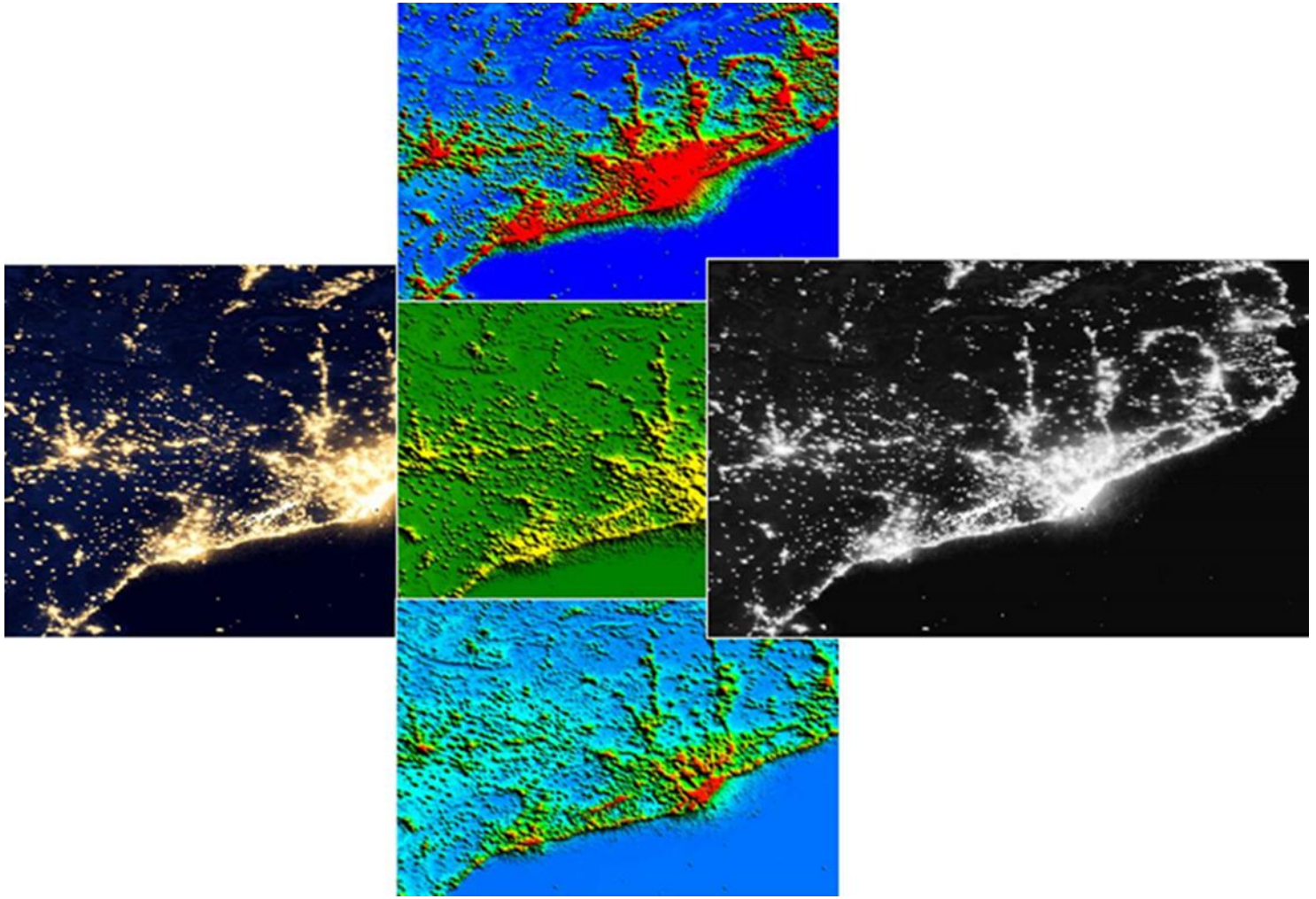
Black Marble:
a georeferenced image of 384 Mb, and 54,000 columns and 27,000 rows and a resolution of 0.00667 degrees per pixel

Methodology used to identify MA

First of all, we analyzed the file supplied by NASA, which offers, in the visible spectrum, three images (RGB) differentiated from night lights.

So it has to proceed to the composition of a single image in conventional greyscale palette (0-255).

Finally, the image conversion from grayscale to elevations allows developing contours at different intensity levels, capable of identifying different hypothesis of urban and metropolitan systems



Methodology used to identify MA

- The transformation of night lights image into a point file allows the realization of a logistic regression with the **Urban Areas** (UA) as a **dependent variable**, and **night light intensity** as an **explanatory variable**

- The logistic regression, adjusted for a total of 18 million points (3.6% of which correspond to UA), allows establishing a level of **164 night light intensity** (in a scale of greys from 0 to 255 levels of intensity) for the determination of those areas **highly impacted by urbanization**. The model gets a 86,4% of effectiveness to explain the UA pattern in USA

Resumen del modelo

Paso	-2 log de la verosimilitud	R cuadrado de Cox y Snell	R cuadrado de Nagelkerke
1	840036,373[a]	,231	,869

a. La estimación ha finalizado en el número de iteración 10 porque las estimaciones de los parámetros han cambiado en menos de ,001.

Tabla de clasificación[a]

Observado			Pronosticado: ua 0	Pronosticado: ua 1	Porcentaje correcto
Paso 1	ua	0	17362503	0	100,0
		1	87931	559718	86,4
	Porcentaje global				99,5

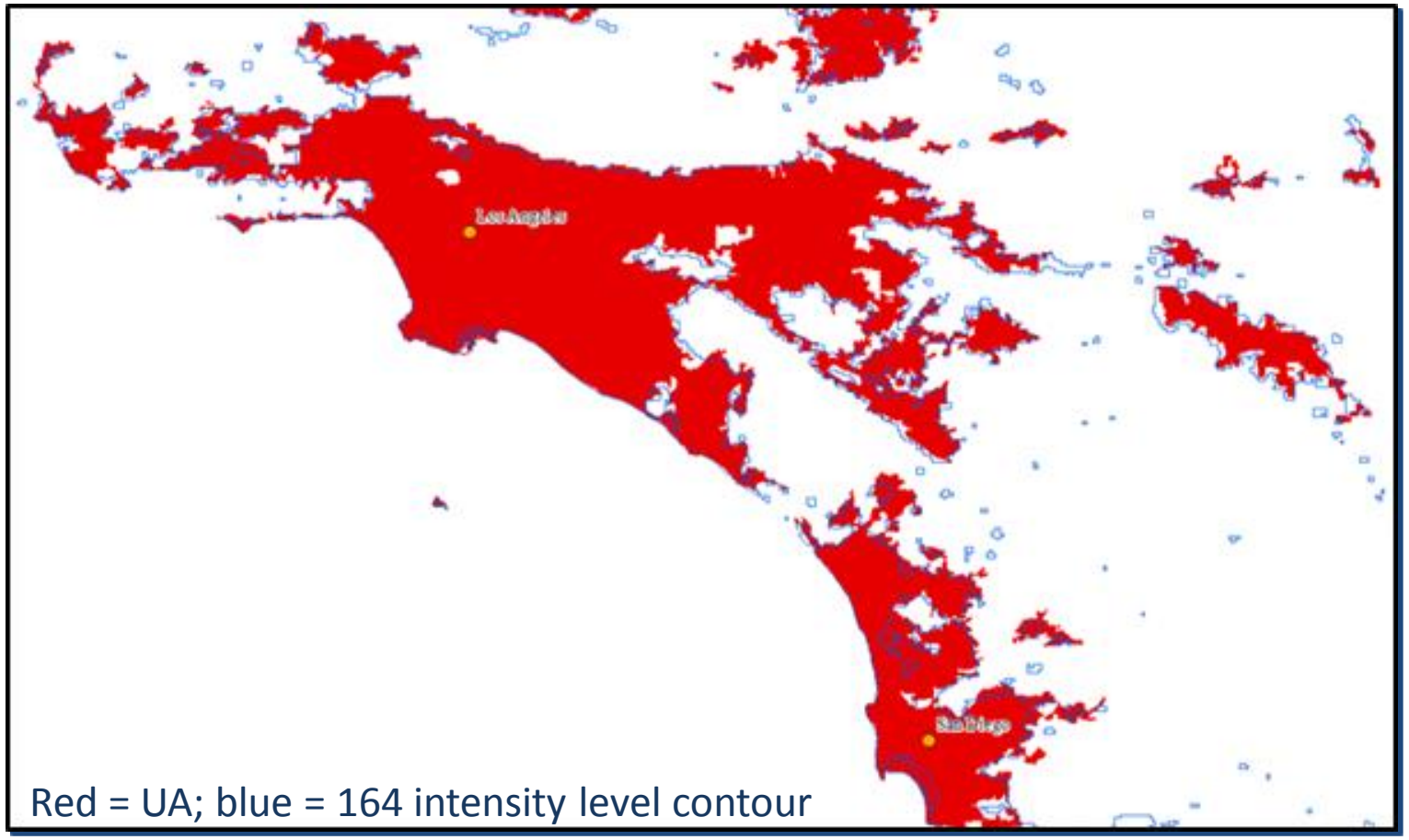
a. El valor de corte es ,500

Variables en la ecuación

		B	E.T.	Wald	gl	Sig.	Exp(B)
Paso 1[a]	grid_code_grey	,067	,000	588521,721	1	,000	1,069
	Constante	-10,842	,013	652029,337	1	,000	,000

a. Variable(s) introducida(s) en el paso 1: grid_code_grey.

Model for the Urban Areas in Southern California

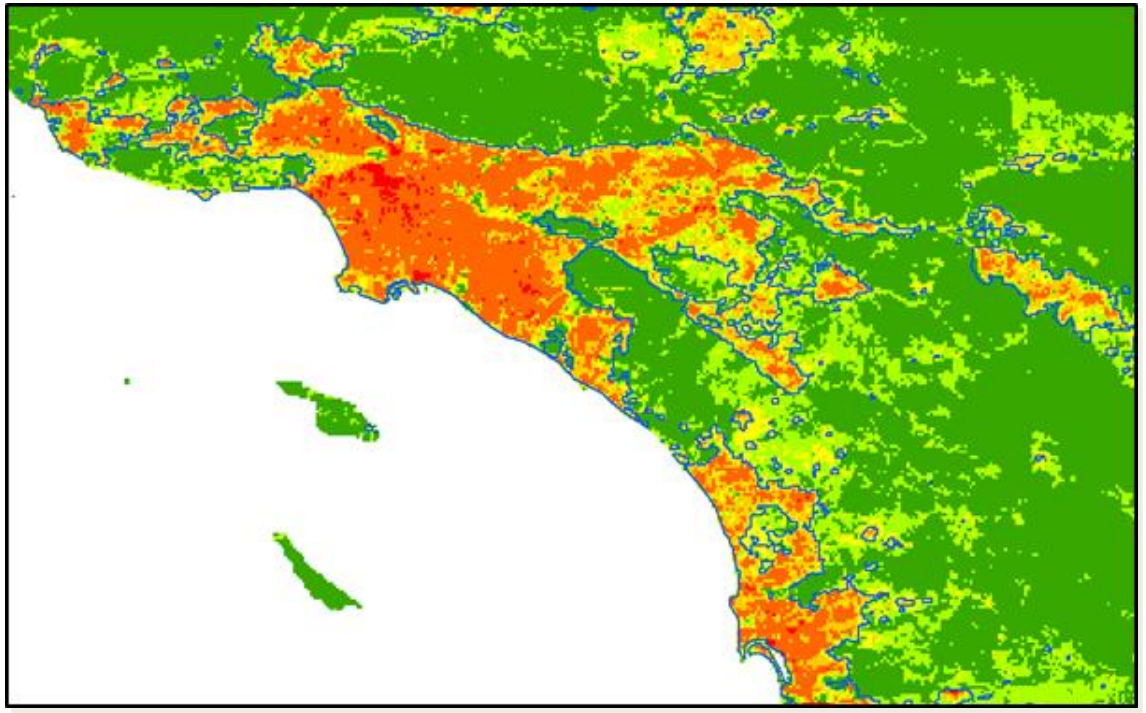


Red = UA; blue = 164 intensity level contour

Methodology used to identify MA

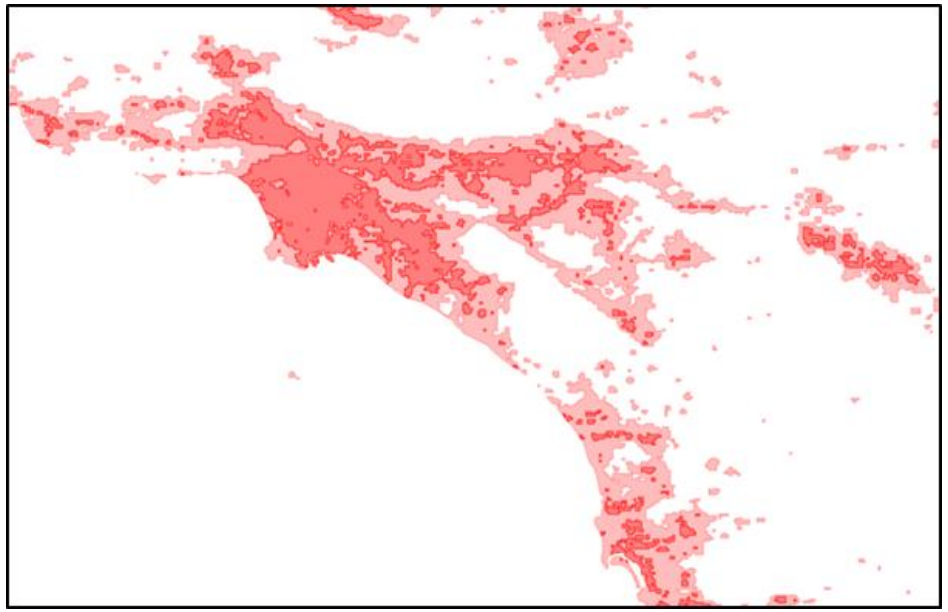
- We have estimated the population of the continuing contours of 164 or higher intensity night lights by overlapping information on population (2008) of the LandScan data base developed by the Oak Ridge National Laboratory, USA. LandScan allows analyzing the population structure of different environments in the urbanized planet, with a close approximation to the reality

- The overlap of highly Impacted Areas (IA), defined based on night lights, with demographic information contained in LandScan allows typify world urban areas based on their population size and to analyze land consumption patterns impacted by urbanization according to that dimension. For the purpose of this study we have considered metropolitan areas the IA with a population equal to or greater than 1,000,000 inhabitants



Green colors =< 50 inhabitants per pixel
Orange and red colors >= 250 inhabitants per pixel

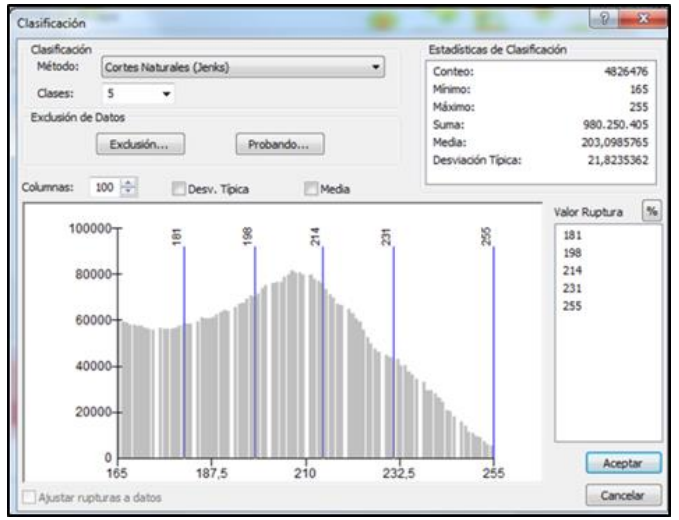
2. How to differentiate centers from peripheries



- This research has developed a specific methodology for distinguishing the central areas (CA) from the Periphery (P) similar to what was done with the areas impacted by urbanization, defined based on a certain level of night lighting

- The delimitation of the centers and peripheries of cities was made by setting a threshold of Impacted Areas allowing the inclusion of most of the centers and sub-centers. The centers threshold corresponds approximately to a light intensity of more than 230, and for the metropolitan peripheries is the rest of the impacted area, between 164 and 230.

- More precisely, the identification of core areas was established through the division into natural breaks (Jenks), with 5 classes, corresponding to the highest class. This class breaks at 230 intensity level, which it has been identified as “centers. The image shows the histogram and natural breaks obtained by ArcGis



3. How to measure Urban Sprawl

- The measure of Urban Sprawl have been made by the indicator: Surface (per capita) Impacted by Urbanization (measured according to the luminous impact), quantified by the ratio between the surface contour of each agglomeration (=> 164 for all typologies of urban systems, > 230 in the case of metropolitan centers and from 164 to 230 for the metropolitan peripheries; and its population). This indicator will be named **Light Impacted Land per capita (LILpc)**

- We distinguish different typologies: **small** (urban systems with a population between 10 and 100,000 inhabitants), **medium** (from 100,000 to 500,000) and **big** (from 500,000 to 1,000,000) **cities**, as well as **metropolitan areas** (more than 1,000,000 inhabitants). In the case of metro areas, we also distinguish centers (with night light intensity > 230) and peripheries (from 164 to 230 intensity)

- The comparison between land consumption of the different typologies of urban systems with metropolitan centers and peripheries allow us to contrast the hypothesis that metropolitan peripheries consume more land per capita and therefore where the urban sprawl is more pronounced

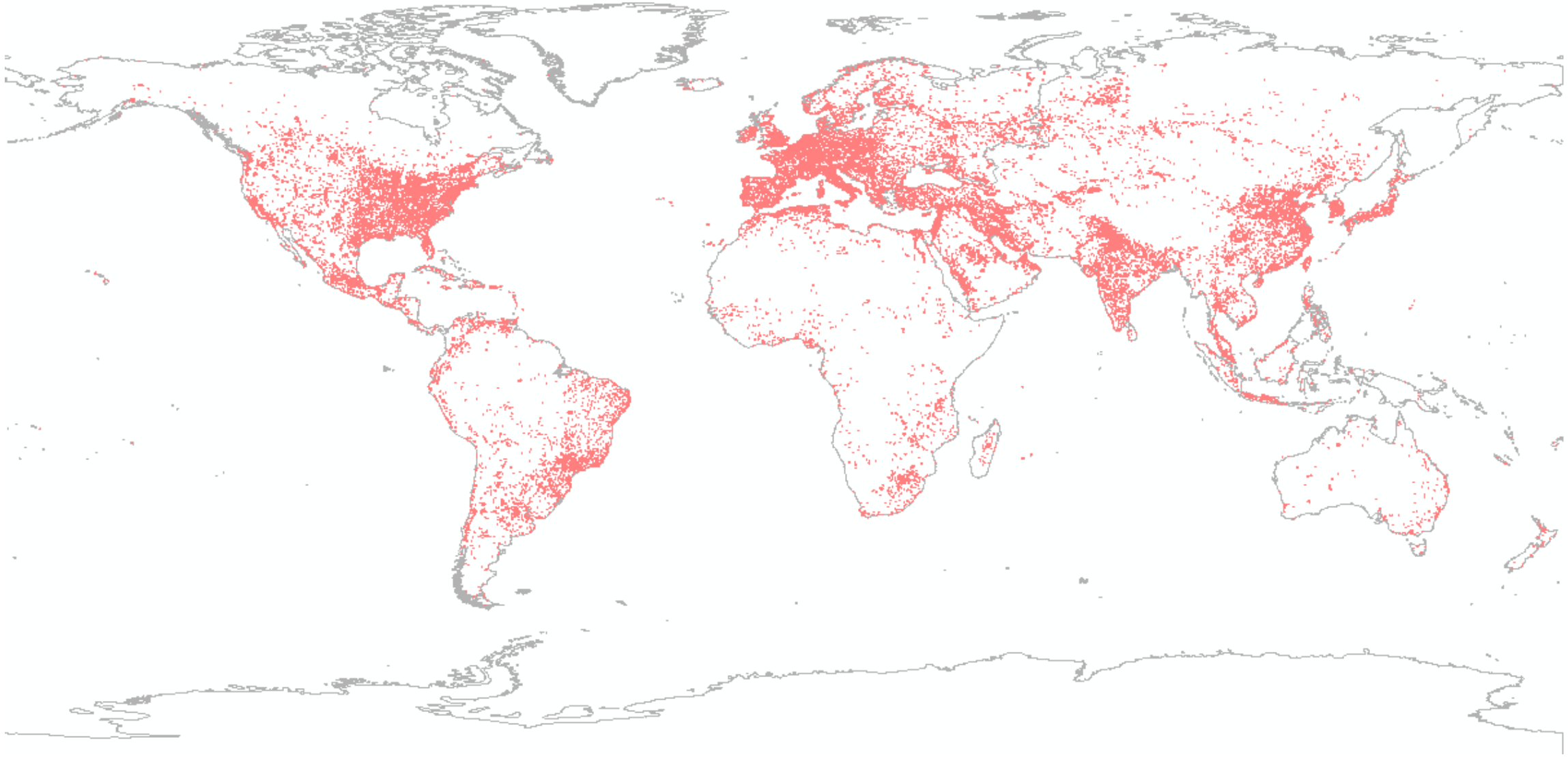
The Results: World Urban Agglomerations

- The application of the methodology proposed, on obtaining the level of light intensity equivalent to the delimitation of the UA in USA, allows the identification of 186.134 populated illuminated areas (intensity =>164)

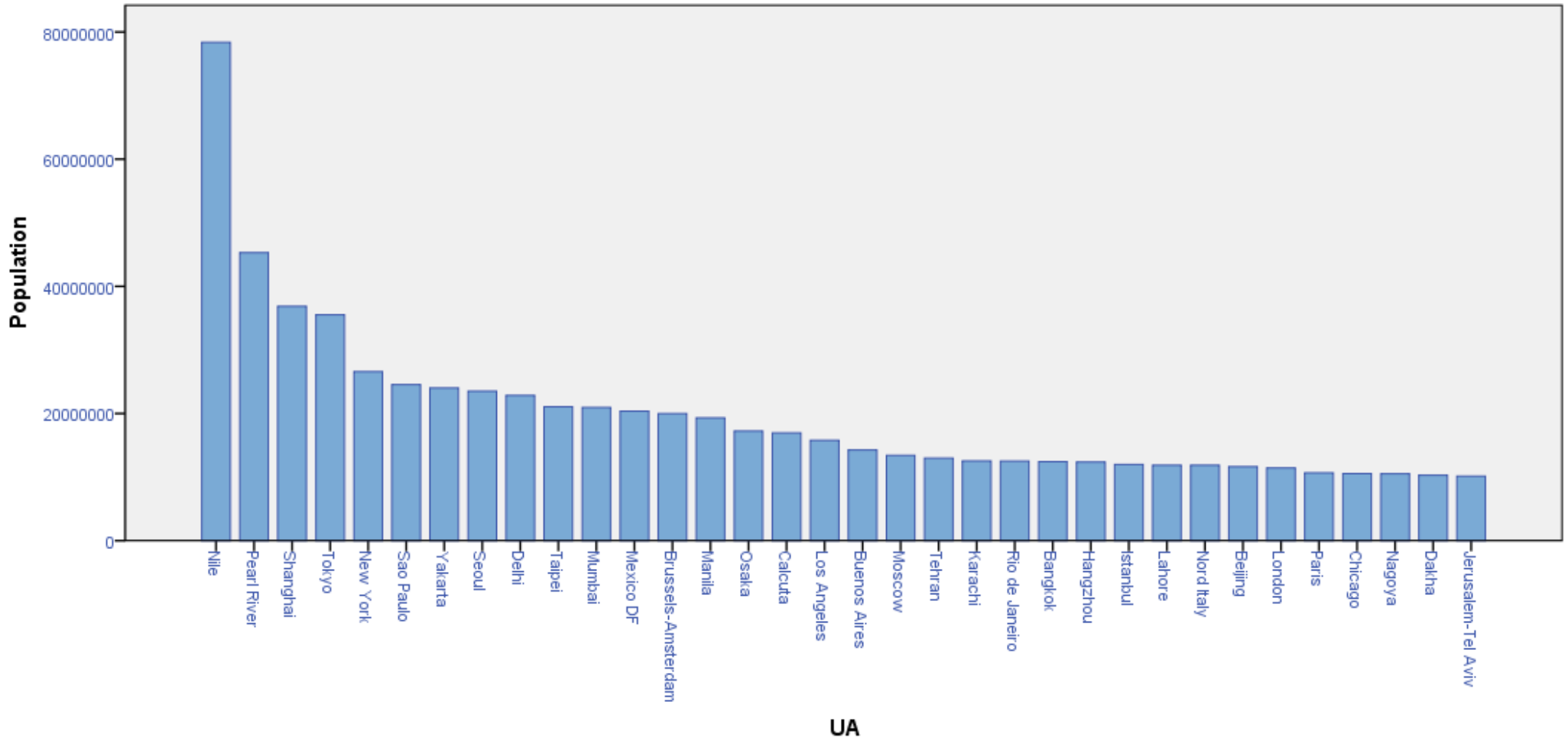
- 404 of these illuminated areas, 2.2 per thousand of the total, can be defined as a metropolises to reach a population of over one million inhabitants, concentrating 1.623 million people, 24.45% of the world population. 34 of those areas exceed 10 million, representing the "seeds" of the megalopolitan structures (Florida et alt, 2008; Arellano & Roca, 2014). On the opposite side to those giants, a 86.94% of the illuminated landscapes (with an intensity equal to or greater than 164) do not exceed 5,000 inhabitants, accounting for 1.45% of the world population.

Population Int. 164	Num. Areas	Population	%
< 100 inhab.	73,861	2,080,640	0,07%
100-1,000 inhab.	56,711	21,996,743	0,75%
1,000-5,000 inhab.	31,249	72,494,669	2,46%
5,000-10,000 inhab.	8,230	58,105,574	1,97%
10,000-50,000 inhab.	10,513	233,741,327	7,93%
50,000-100,000 inhab.	2,431	169,608,631	5,76%
100,000-500,000 inhab.	2,372	506,136,689	17,18%
500,000/1,000,000 inhab.	363	258,781,784	8,78%
1,000,000-5,000,000 inhab.	328	669,451,270	22,72%
5,000,000-10,000,000 inhab.	42	282,833,771	9,60%
>= 10,000,000 inhab.	34	670,749,830	22,77%
TOTAL	186,134	2,945,980,928	

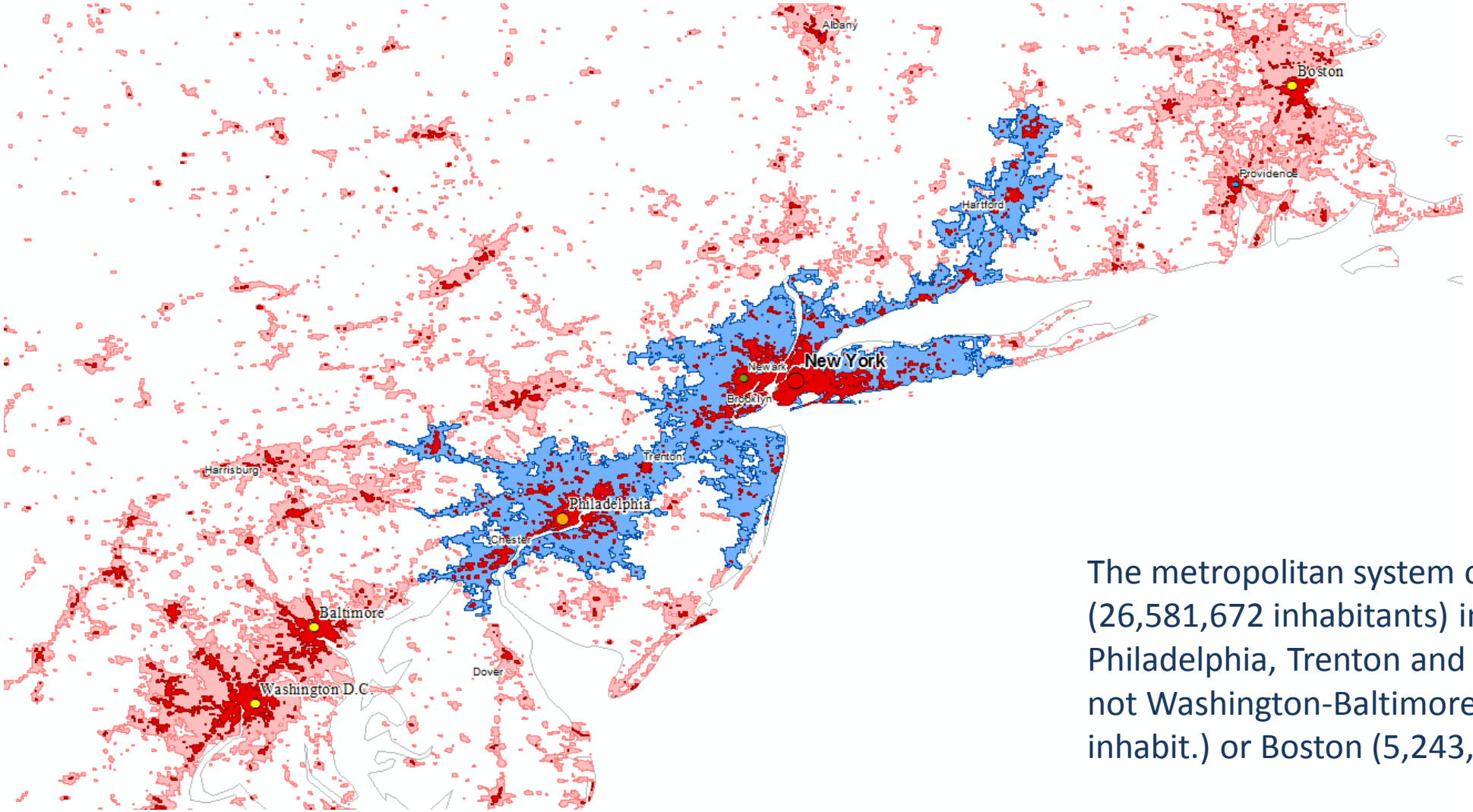
World Urban Agglomerations



Megacities (population > 10,000,000 inhabitants)

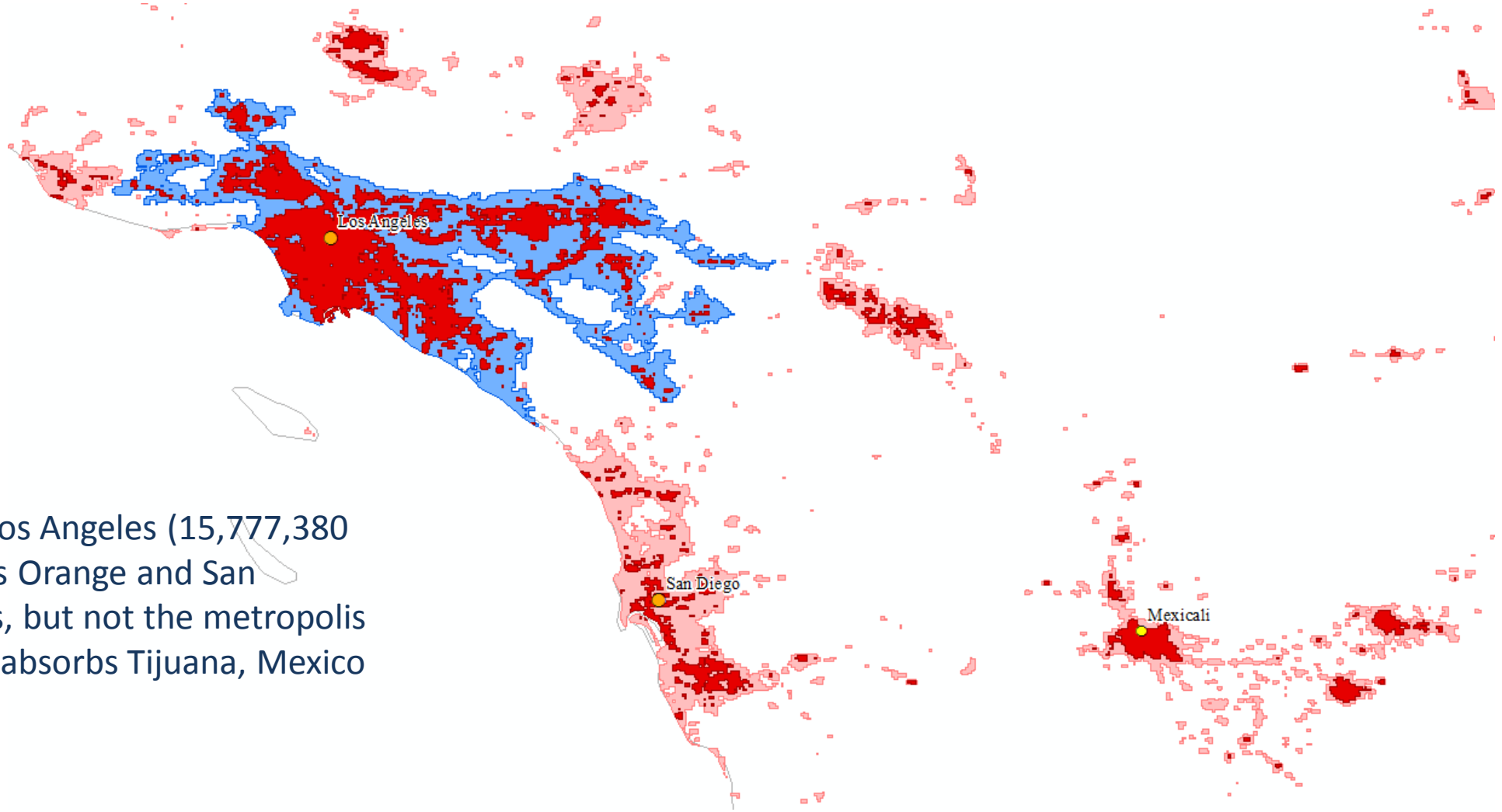


New York – Philadelphia Metropolitan Area



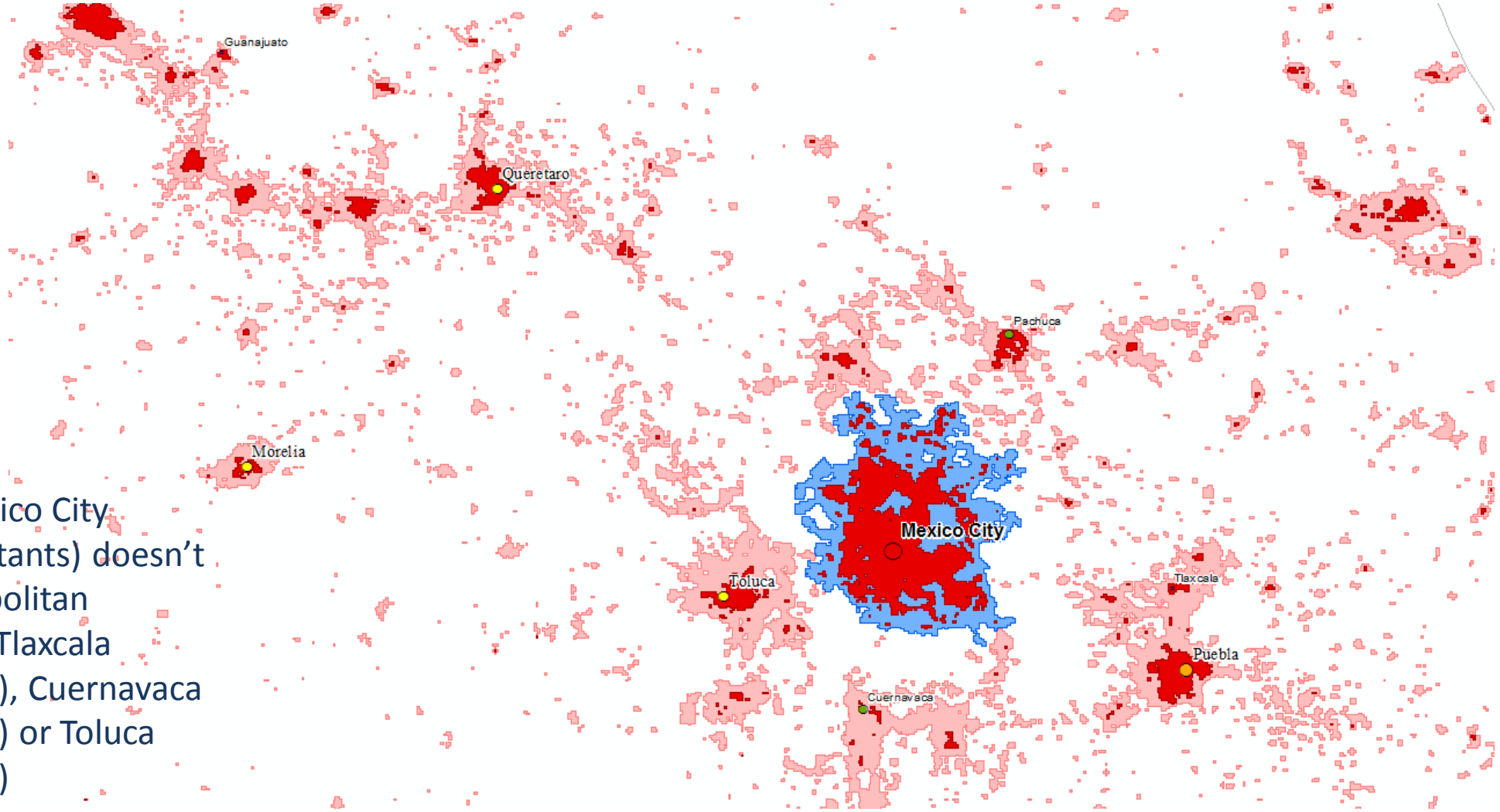
The metropolitan system of New York (26,581,672 inhabitants) includes Philadelphia, Trenton and Hartford, but not Washington-Baltimore (6,986,575 inhabit.) or Boston (5,243,601 inhabit.)

Loa Angeles Metropolitan System



The Metro Area of Los Angeles (15,777,380 inhabitants) includes Orange and San Bernardino Counties, but not the metropolis of San Diego, which absorbs Tijuana, Mexico (4,192,676 inhabit.)

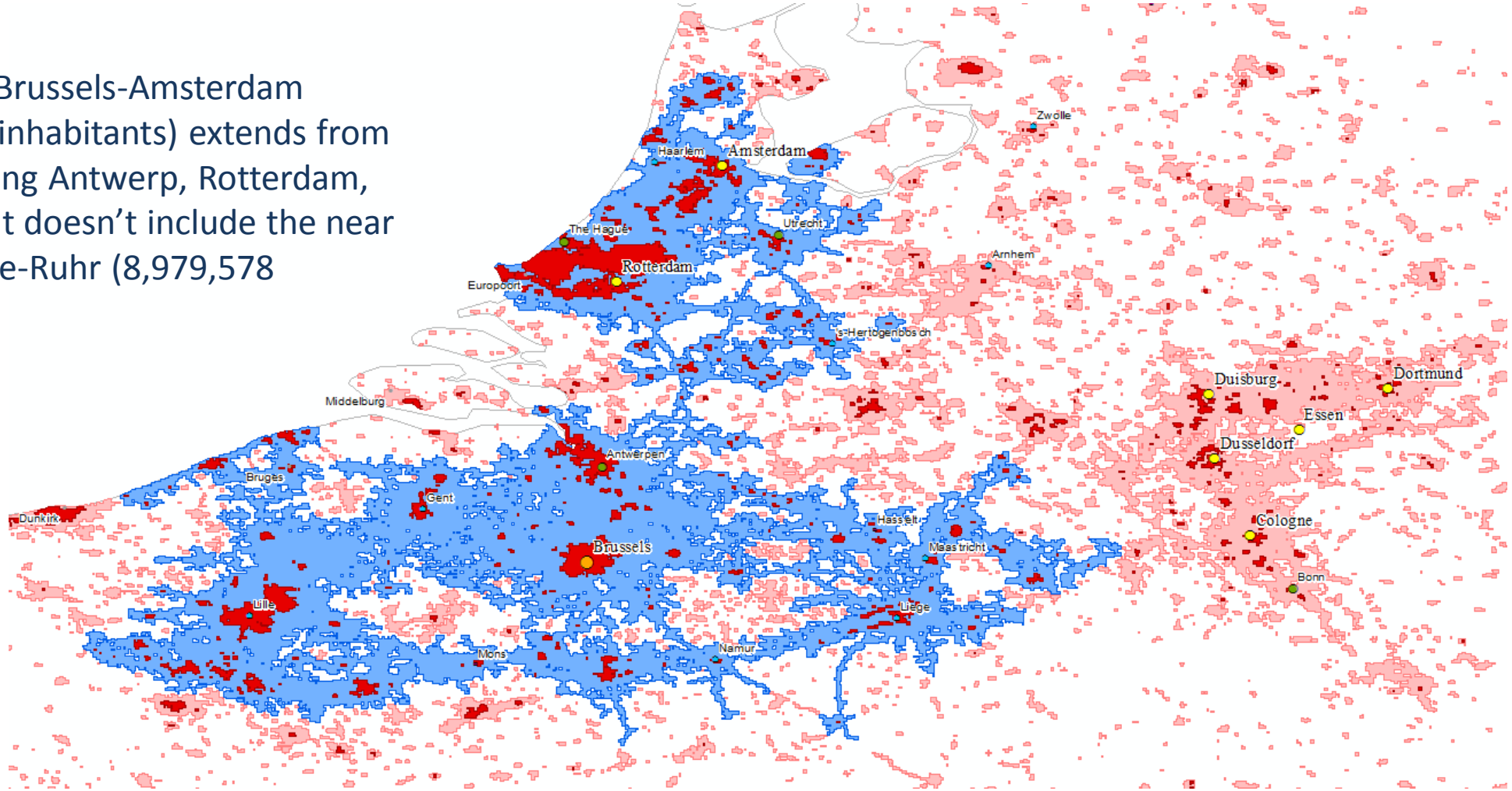
Mexico City



Metro Area of Mexico City (20,378,028 inhabitants) doesn't include the metropolitan systems of Puebla-Tlaxcala (2,797,846 inhabit.), Cuernavaca (1,285,314 inhabit.) or Toluca (1,801,168 inhabit.)

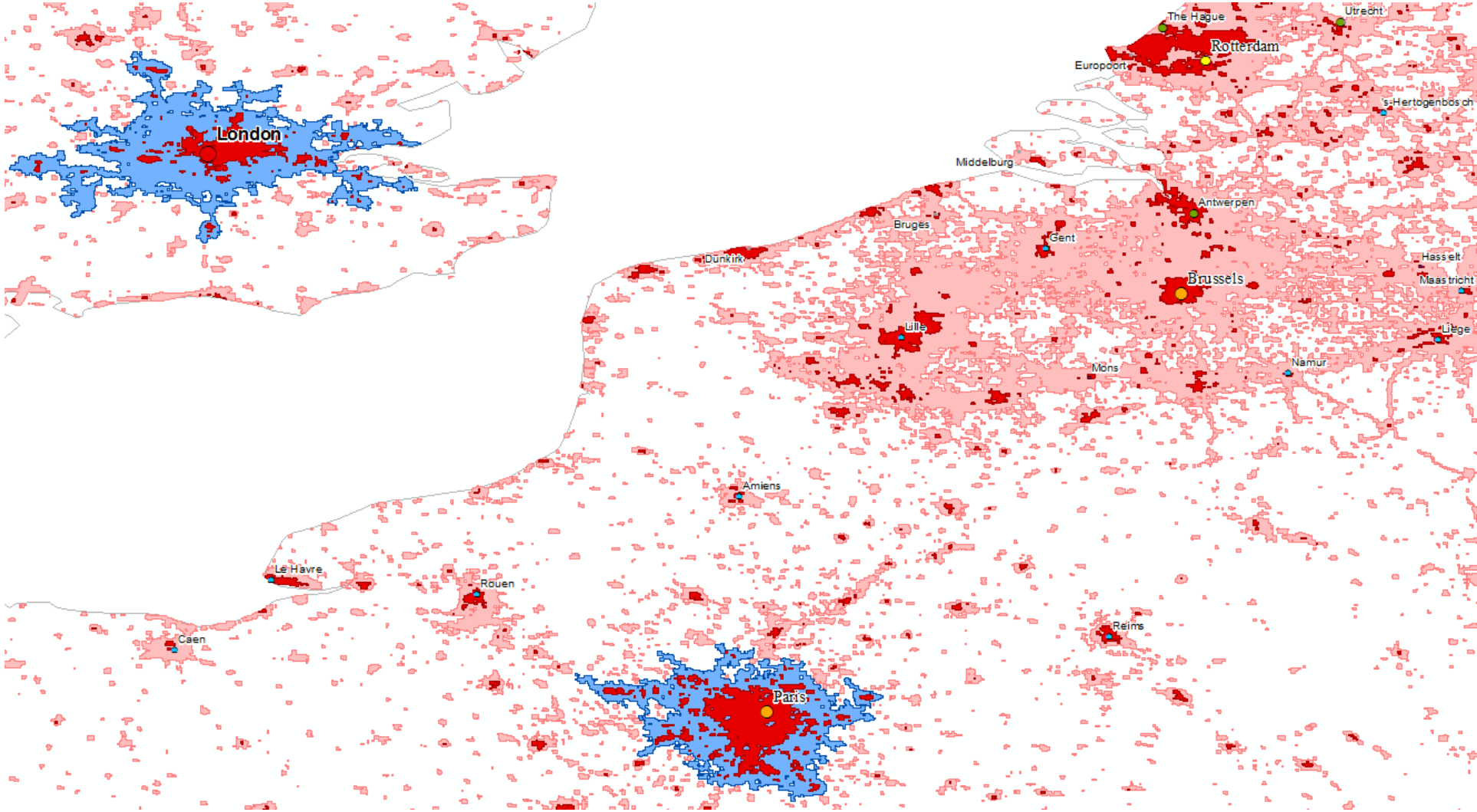
Brussels-Amsterdam agglomeration

The agglomeration of Brussels-Amsterdam (nearby 20 millions of inhabitants) extends from Lille to Utrecht, including Antwerp, Rotterdam, The Hague and Liege. It doesn't include the near metropolis of the Rhine-Ruhr (8,979,578 inhabitants)



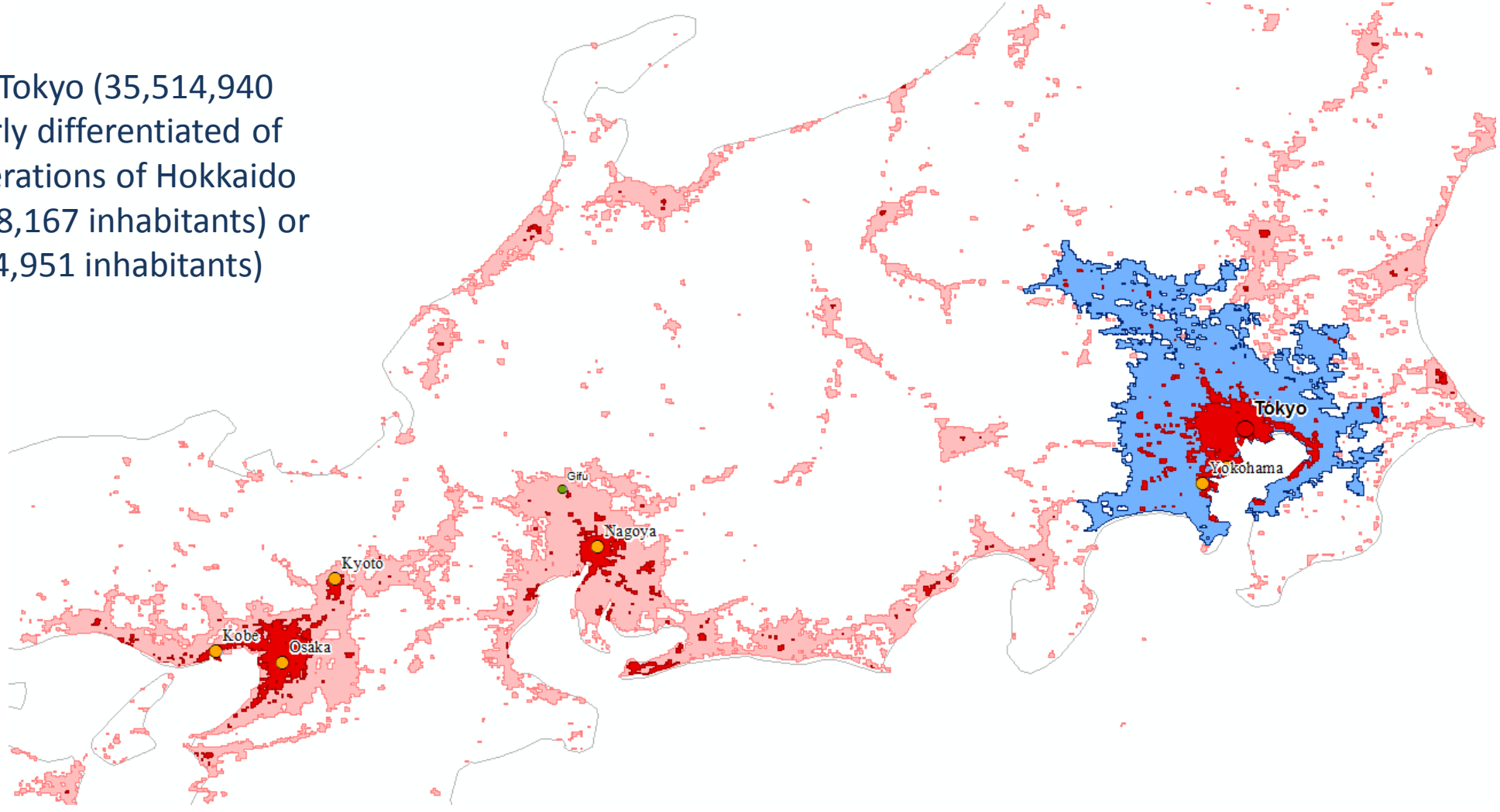
Metro Areas of Paris and London

In front of the agglomeration of Brussels-Amsterdam not only Rhine-Ruhr seems small. Also Metropolitan Areas of Paris (10,672,304 inhabitants) or London (11,420,350 inhabitants) are smaller



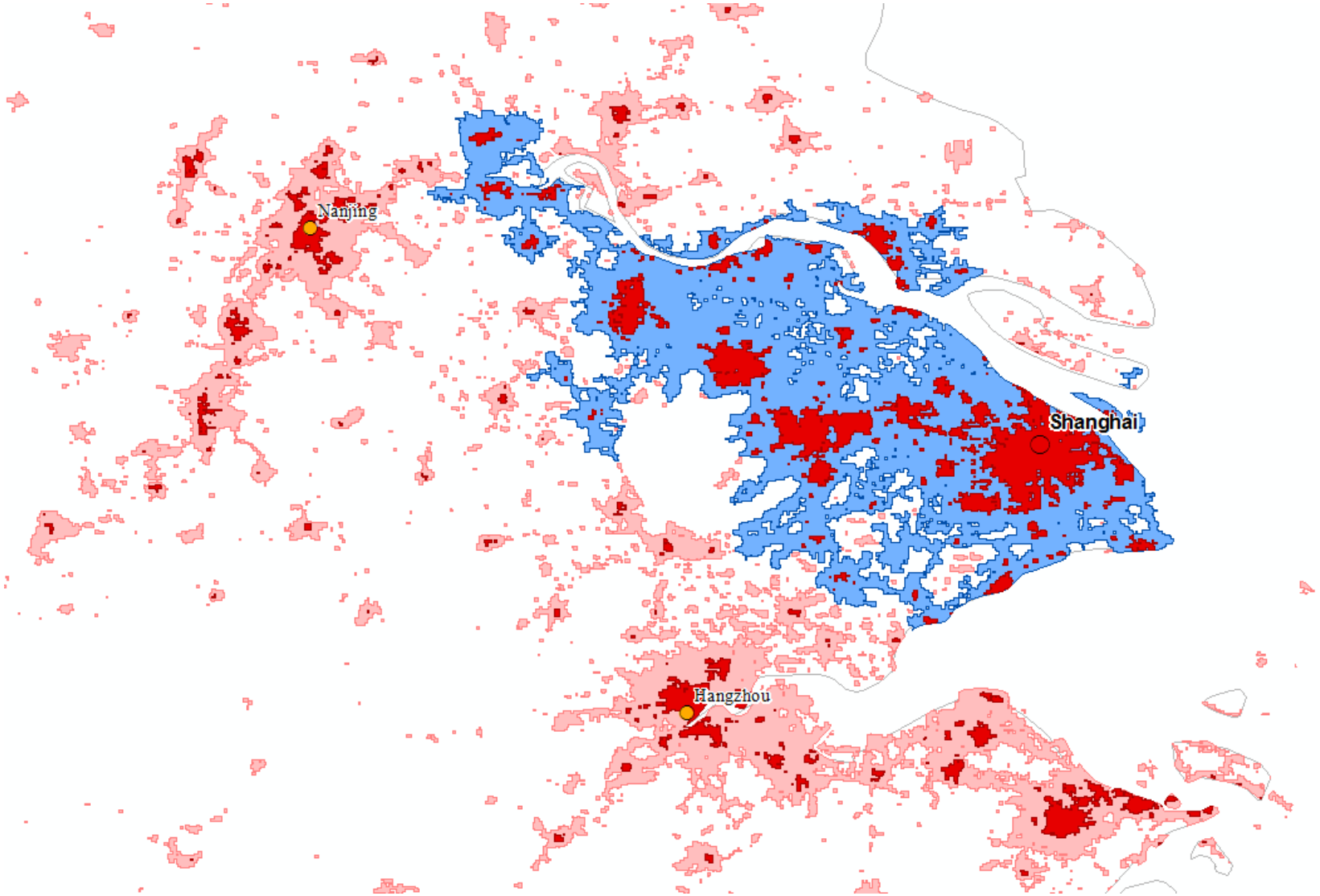
Metro Area of Tokyo

The metropolitan area of Tokyo (35,514,940 inhabitants) appears clearly differentiated of the others urban agglomerations of Hokkaido Island, like Nagoya (10,528,167 inhabitants) or Kyoto-Osaka-Kobe (17,234,951 inhabitants)

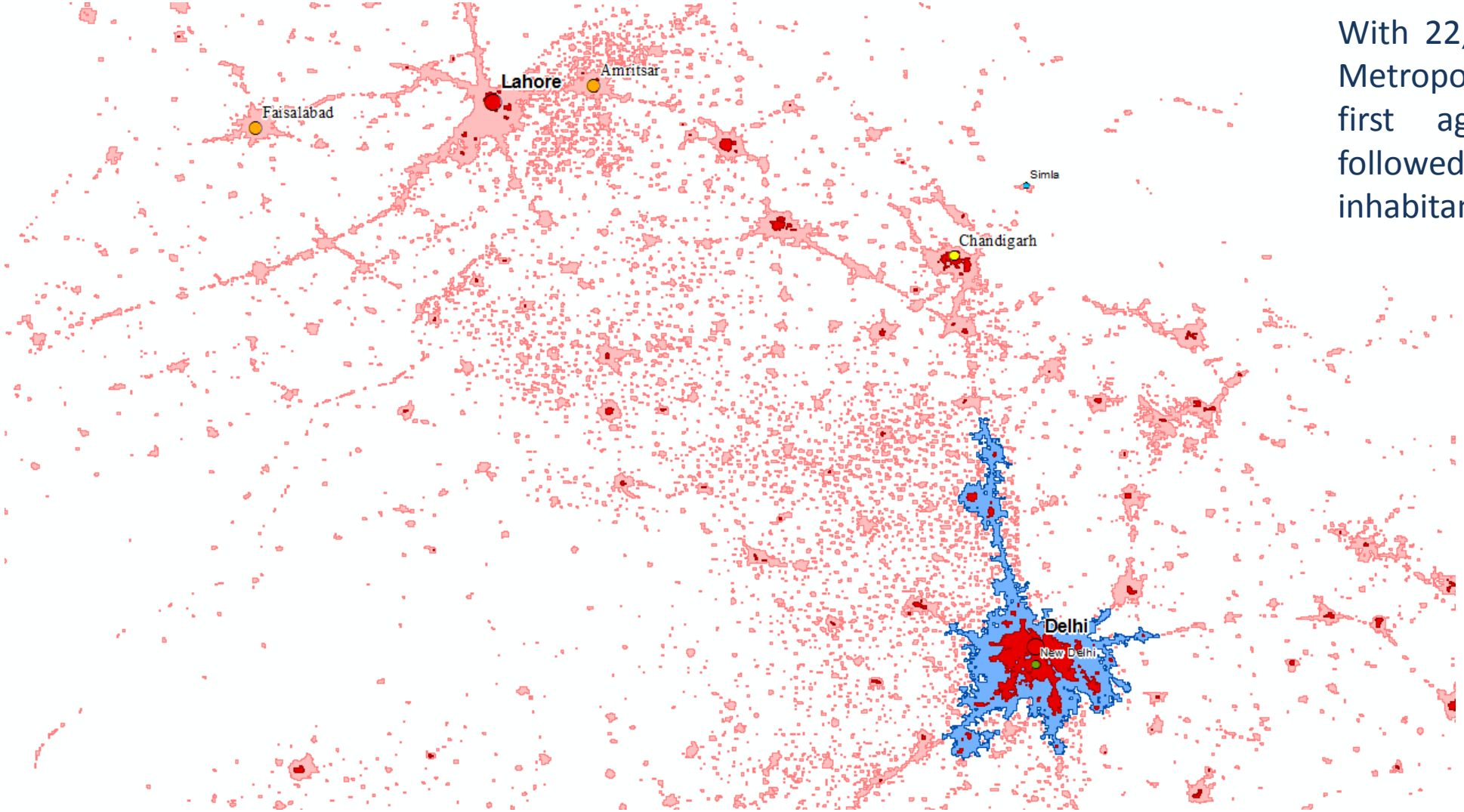


Metropolitan Area of Shanghai

The Metro Area of Shanghai (36,853,534 inhabitants), with Nantong, Changzhou, Wuxi and Suzhou as major cities, is the third metropolitan system in our ranking based on night lights. It appears clearly differentiate of Nanjing (6,606,566 inhabitants) and Hangzhou (12,356,984 inhabitants) agglomerations



Delhi Metro Area



With 22,851,644 inhabitants, the Metropolitan Area of Delhi is the first agglomeration in India, followed by Mumbai (20,953,305 inhabitants)

Metropolis and Sprawl

- We consider sprawled agglomerations those with a LILpc > average + 1 standard deviation, that means more than 918 m2 / inhab.
- Values above 0 mean that are larger than LILpc average. Values above 1, LILpc > average + 1 Std. Est.
- Negative values mean areas with below average sprawl.
- 47 of the 404 MA have values above 1
- Most affected areas are located in USA (27)
- Countries Oil producers also bring a number of significant MA with a higher LILpc, perhaps the effect of oil exploitation
- The standardized LILpc value is a good indicator of Sprawl

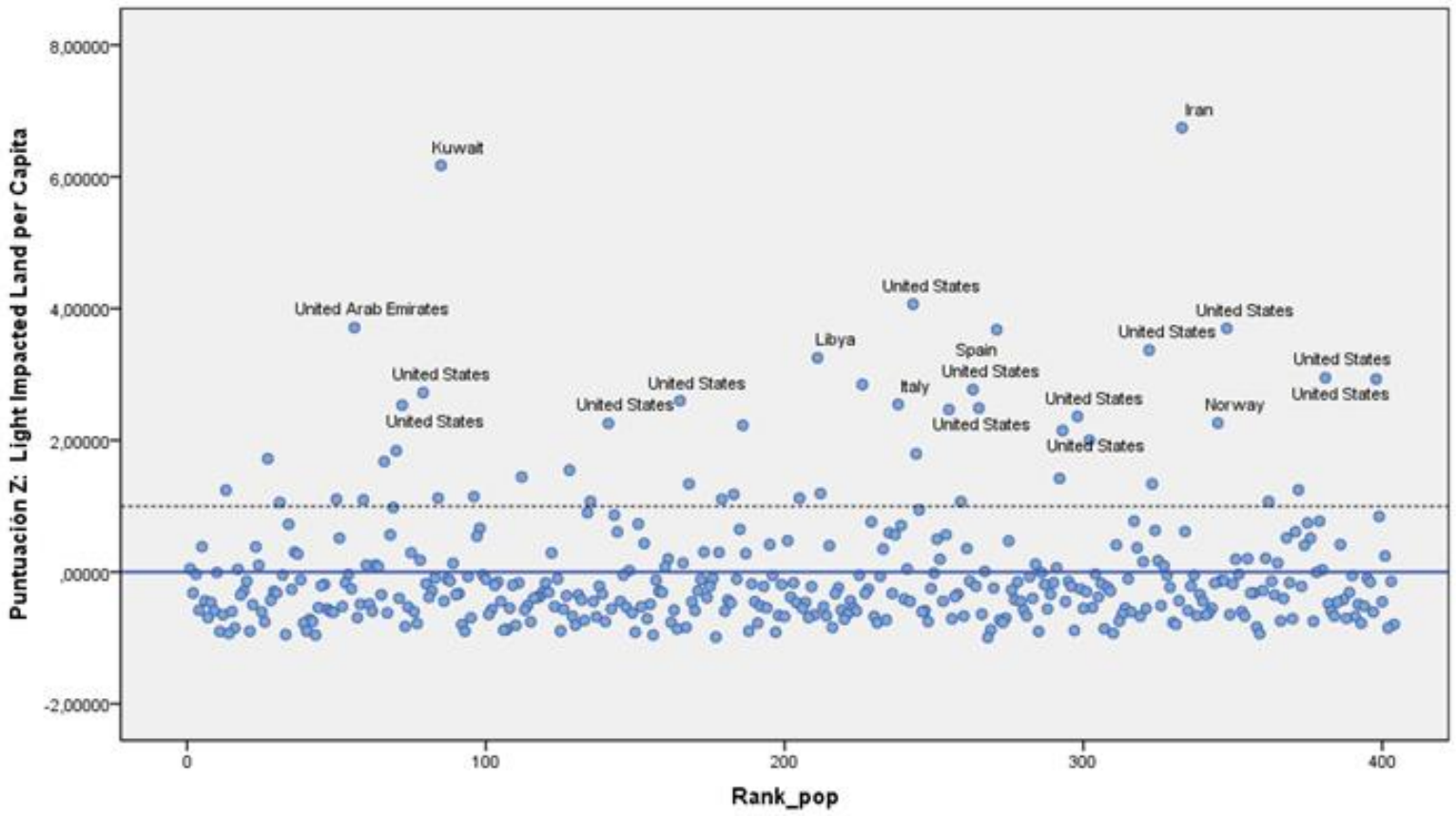
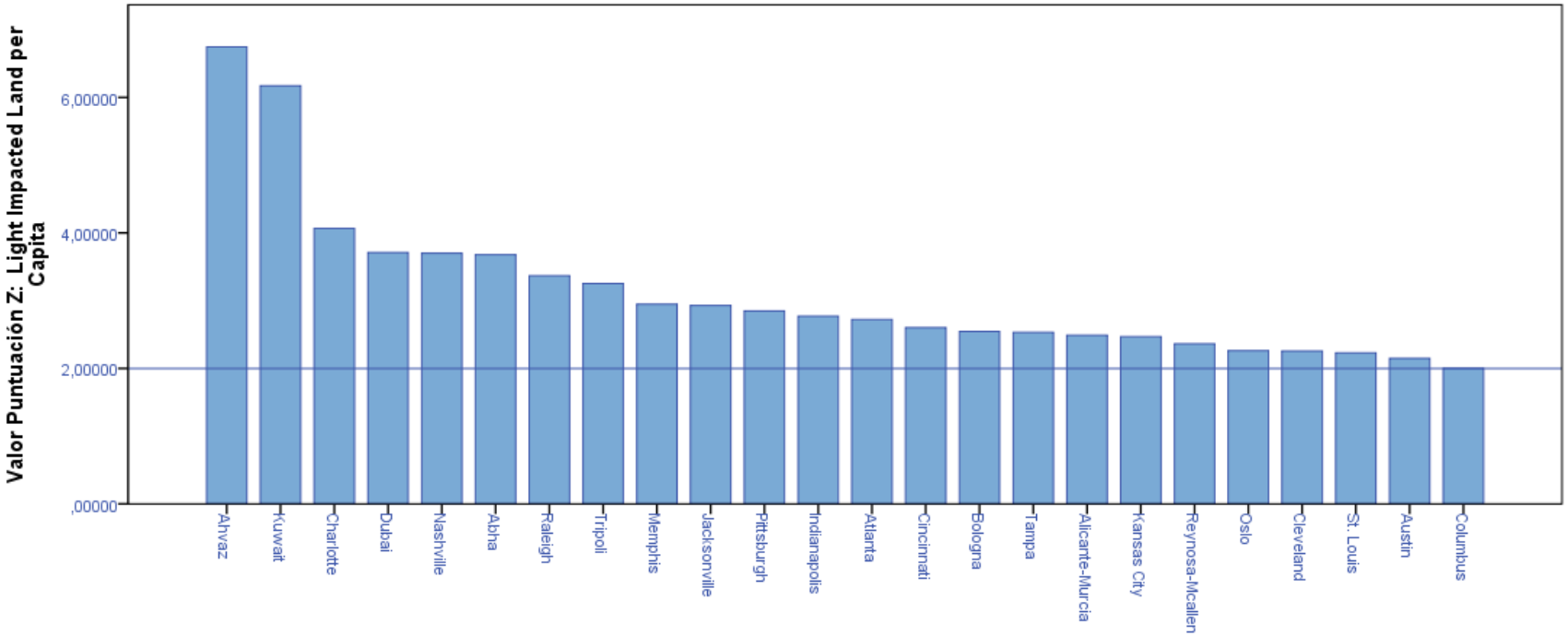


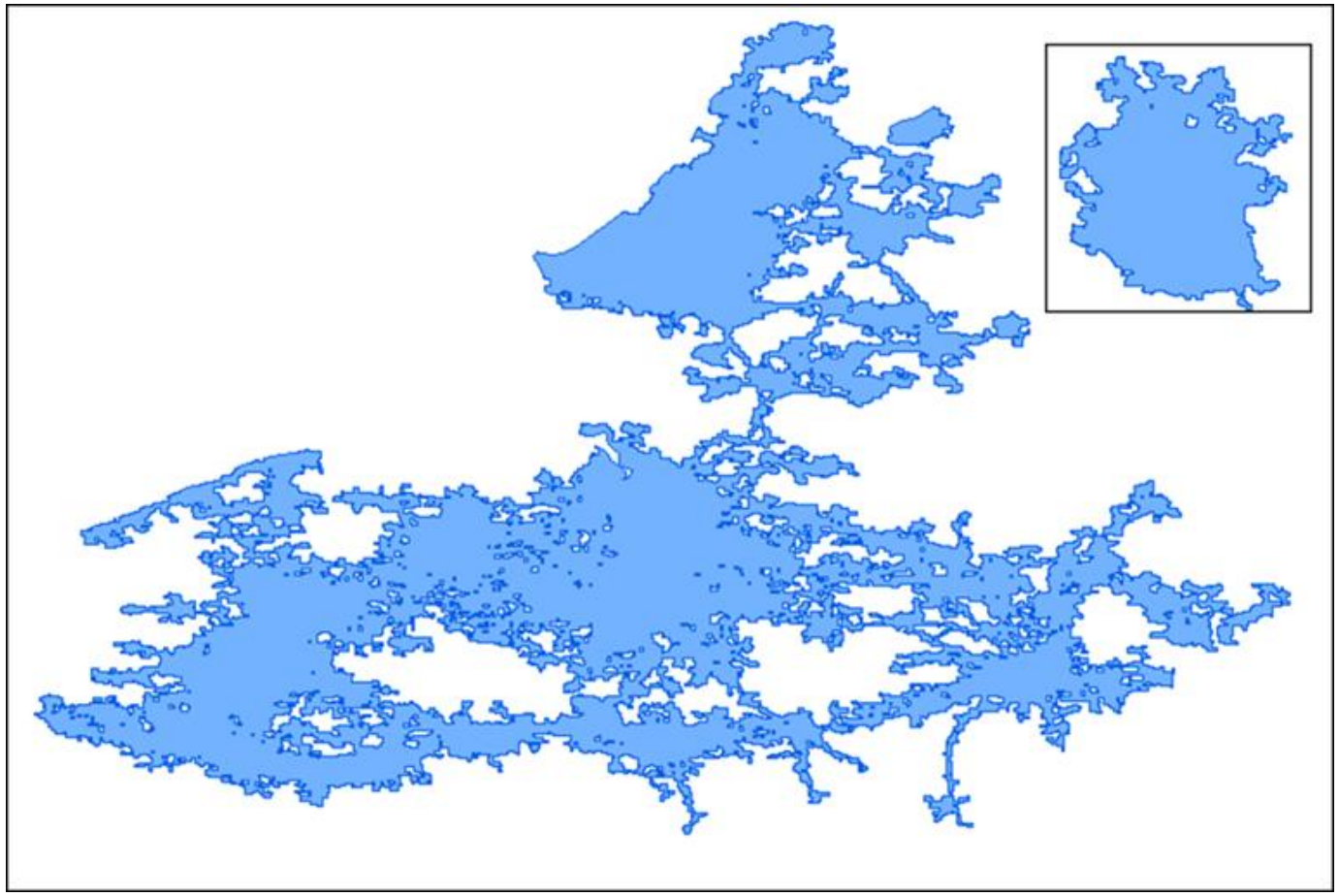
Figure shows agglomerations with standardized LILpc greater than 2

Leaders in Urban Sprawl

Leaders in urban sprawl (standardized LILpc > 2) are the 24 following metropolises: Ahvaz (Iran), Kuwait (Kuwait), Charlotte (United States), Dubai (United Arab Emirates), Nashville (United States), Abha (Saudi Arabia), Raleigh (United States), Tripoli (Libya), Memphis (United States), Jacksonville (United States), Pittsburgh (United States), Indianapolis (United States), Atlanta (United States), Cincinnati (United States), Bologna-Modena-Parma (Italy), Tampa (United States), Alicante-Murcia (Spain), Kansas City (United States), Reynosa-Mcallen (United States-Mexico), Oslo (Norway), Cleveland (United States), St. Louis (United States), Austin (United States), and Columbus (United States)



Comparison between Metro Areas



The study allows to compare metropolitan sprawl

Two metropolitan areas with similar population (20 million inhabitants); Brussels-Amsterdam and Mexico City. The first one impacts 20,458.10 square kilometers, the second, just 4,150.86

The LILpc indicator goes from 203.69 m2 per inhabitant in Mexico City, to 1,023.16 in central European agglomeration

Centers and Peripheries

- Once estimated Sprawl of metropolitan areas, it is useful to polish this study distinguishing between centers and peripheries. It could happen that a metropolitan area as a whole could not be characterized as disperse due to the high density of the center.

- For this purpose we have differentiated **central areas**, identified by the contours of **light intensity above 230**, and **peripheries (164-230)**

- If a reference value of **1,000 m2 / inhabitant is adopted to consider a landscape as sprawled**, some cities traditionally considered as dense, show a significant level of sprawl in their peripheries, such as Barcelona, Mexico City, Buenos Aires, Rio, Seoul or Taipei, appearing with alarming levels of sprawl in the periphery

Estadísticos

		Light Impacted Land per Capita	LILPC_c230	LILPC_Perif230
N	Válidos	404	394	394
	Perdidos	0	10	10
Media		484,920980	188,4305	1597,3253
Mediana		357,844605	123,7803	744,4005
Desv. típ.		433,0966815	175,81986	4329,18252
Percentiles	5	105,025434	36,3945	141,8043
	10	153,419531	48,5818	202,1617
	15	183,635173	55,7451	251,2205
	20	204,824200	69,6603	324,0824
	25	229,144302	79,0828	378,9258
	30	248,845164	87,6257	441,3414
	35	280,485150	96,7098	499,9907
	40	298,533167	103,6470	554,8837
	45	334,914605	115,3307	649,6782
	50	357,844605	123,7803	744,4005
	55	390,743001	138,7940	832,0626
	60	414,914300	149,8539	989,0681
	65	443,061766	166,5551	1121,3902
	70	482,097955	186,5171	1266,9801
	75	562,333907	231,0054	1420,1785
	80	660,089696	270,6633	1678,8608
	85	767,384847	310,9867	2239,8578
	90	967,332257	474,1224	2621,7791
	95	1464,042793	608,6733	3560,7859

Comparison between typologies of Urban Systems (I)

- Although the impacted land by inhabitant decreases with the size of the city and metropolitan areas "consume" less land than the rest of urban systems (due to economies of agglomeration), **the landscape of metropolitan peripheries impact or consume more land**. At global scale, only small cities impact more than the peripheries of the metropolises (876.21 vs 786.08 m2/inhabitant)

- **In North America the levels of urban sprawl are widespread, affecting not only the metropolitan peripheries but also small towns, medium and even large cities.** All typologies, with the exception of metropolitan centers, show a LILpc greater than 1,000 m2 by inhabitant. The Urban Sprawl is concentrated in small cities (LILpc = 1,809.18) and metropolitan peripheries (LILpc = 1,523.22)

	World	Europa	Amer. Nor	Amer. Sur	Asia	África	Aust_NZ
Ciudades Pequeñas	876,21	991,13	1.809,18	910,78	598,63	632,80	1.122,26
Ciudades Medias	595,74	694,42	1.351,09	540,45	451,35	371,16	875,27
Ciudades Grandes	605,78	622,03	1.193,19	607,58	468,72	379,68	-
Áreas Metropolitanas	446,09	631,60	791,80	314,91	349,32	374,92	659,99
Centros AM	164,90	202,93	340,52	123,58	120,19	116,82	431,19
Periferia AM	786,08	1.009,82	1.523,22	1.303,47	590,34	624,32	713,47

Comparison between typologies of Urban Systems(II)

Mexico and USA show a highly differentiated process of urbanization

- In USA the sprawl is not concentrate only or mainly in metropolitan peripheries, but throughout all category of urban systems, especially small (LILpc = 2,356.36), medium-sized cities (LILpc = 1,822.52) and metropolitan peripheries (LILpc = 1,703.75). Atlanta is a good example of sprawled metropolis (with a LILpc = 1,663.85 the metro area) opposed to **Los Angeles, which is the most compact metropolis in the USA** (LILpc = 503.03 the overall metro area and LILpc = 948.49 in the periphery)

- In Mexico, certainly there is a process of sprawl, but the Urban Sprawl only affects, and so accused, the metropolitan peripheries, with an impact of 1.529 m2 / capita, that is close to the USA's indicator. The example of Mexico City is relevant: with one of the densest patterns worldwide for its core areas (95 m2 per capita), its periphery (1,616 m2 / inhabitant) shows levels of sprawl even higher than New York - Philadelphia metro area. Mexican metropolitan peripheries are disperses in all cases, but tend to be less in the northern agglomerations, like Ciudad Juarez or Mexicali

	USA	México
Ciudades Pequeñas	2.356,36	759,94
Ciudades Medias	1.822,52	649,45
Ciudades Grandes	1.625,04	540,42
Áreas Metropolitanas	988,74	329,17
Centros AM	450,76	121,18
Periferia AM	1.703,75	1.529,78

	NY	Los Ángeles	Chicago	Atlanta
Áreas Metropolitanas	651,20	503,03	941,77	1.663,85
Centros AM	194,45	288,88	469,32	681,28
Periferia AM	1.269,45	948,49	1.929,56	2.193,16

	MEX DF	Mexicali	Ciudad Juárez	Guadalajara	Monterrey	Puebla
Áreas Metropolitanas	203,69	757,54	691,00	344,22	436,99	494,23
Centros AM	94,67	352,06	352,85	139,60	178,39	150,99
Periferia AM	1.616,10	5.700,64	3.182,20	2.621,33	2.622,23	1.077,42

Comparison between typologies of Urban Systems(III)

In Europe, the main impact is on the metropolitan peripheries: LILpc is higher on the periphery of metropolis than in medium and small cities

- The illuminated contours (=> 164 current) with a population between 10,000 and 100,000 inhabitants (2,784 areas), or **small cities**, grouped 88.7 million people and have a **LILpc of 991.13 m2/inhabitant**
- Urbanized areas with a population between 100,000 and 500,000 inhabitants (430 contours), or **medium-sized cities**, grouped a population of 90.8 million inhabitants, have a **LILpc of 694.42 m2/inhabitant**
- **Large cities** with a population between 500,000 and 1,000,000 (61 contours), hosting a total of 43.8 million inhabitants, show a smaller impact of **622.03 m2/inhabitant**
- **Metro areas of over 1 million inhabitants** (60 contours) grouped 190.9 million people, 89.5 million corresponding to the centers and 101.4 million to the peripheries. The peripheries impact is 1,009.82 m2/inhabitant, against 202.93 of the centers.

We can conclude that it is in metropolitan peripheries where sprawl processes are most pronounced in Europe. The fact that LILpc of peripheries is highly than 1,000 proves that Urban Sprawl is a generalized problem in European metropolises

Comparison between typologies of Urban Systems(IV)

In South America, the Urban Sprawl processes are concentrated in metropolitan peripheries (LILpc = 1,303.47), overpassing the cut off of 1,000 m2 per inhabitant.

Agglomerations like Sao Paulo (LILpc = 1,397.19), Buenos Aires (LILpc = 3,362.38), Rio de Janeiro (LILpc = 1,170.50), Bogota (1,157.02), Belo Horizonte (1,132.48), Caracas (1,340.74), Medellin (1,266.25), Porto Alegre (1,102.85), Valencia (1,467.98), Fortaleza (1,263.04), Curitiba (1,267.71), Brasilia (1,891.83), Maracaibo (2,805.34) or Cali (1,747.56), are good examples of sprawl in south American metropolitan peripheries.

Africa and Asia show similar patterns of light impacted land. The sprawl doesn't seem to be an accused problem in these continents. Although 42 between 200 metropolises in Asia show levels of highly metropolitan peripheral sprawl.

Agglomerations like Kuwait, Dubai, Riyadh, Medina, Mecca, Ad Daman, or Abba in Saudi Arabia, Mashhad, Tehran or Esfahan in Iran, Baghdad in Iraq, Jerusalem-Tel Aviv, Damascus, Amman, Beirut, Ankara or Izmir in Turkey, Seoul or Pusan in South Korea, Hyderabad in India, Tianjin in China or Kuala Lumpur in Malaysia, have sprawled peripheries (=> 1,000 m2 per inhabitant). In the case of Africa, just 8 of 38 metropolises have disperse peripheries, including cities as Tripoli (Libya), Luanda (Angola), Lusaka (Zambia), Algiers (Algeria), or Casablanca, Rabat or Marrakech in Morocco.

Australia-New Zealand expressed a level of Sprawl accused in small towns. Perth and Brisbane, from 6 metropolitan areas, show disperses peripheries

Conclusions

The study shows that night lights satellite image have a high potential for analysis of urban and metropolitan systems. The results appear to be consistent with most metropolitan delimitations

The application of the methodology proposed, on obtaining the level of light intensity equivalent to the delimitation of the Urban Areas in the USA, allows the identification of 186.134 populated illuminated areas (intensity =>164). 404 of these illuminated areas, 2.2 per thousand of the total, can be defined as a metropolises to reach a population of over one million inhabitants

We have used the Light Impacted Land per capita (LILpc) as indicator of Urban Sprawl and considered sprawled agglomerations those with a LILpc > average + 1 standard deviation, that is more than 918 m2 / inhab. 47 of the 404 Metro Areas are in that situation. Most of these affected areas are located in USA (27). Countries Oil producers also bring a number of significant MA with a higher LILpc, perhaps the effect of oil exploitation

Metropolises like Kuwait (Kuwait), Dubai (United Arab Emirates), Nashville, Memphis, Jacksonville, Pittsburgh, Indianapolis, Atlanta, Cincinnati, Austin, Kansas City, St. Louis, Cleveland or Columbus (United States), Bologna-Modena-Parma (Italy), and Murcia-Alicante (Spain) are the best samples of sprawled agglomerations

Conclusions

Also in metropolitan areas we have distinguish between central areas and peripheries. If a reference value of 1,000 m2 / inhabitant is adopted to consider a landscape as sprawled, some cities traditionally considered as dense, show a significant level of Sprawl in their peripheries. Relatively dense cities such as Barcelona, Mexico City, Buenos Aires, Rio, Seoul or Taipei, appearing with alarming levels of sprawl in the periphery

At global scale, only small cities impact more than the peripheries of the metropolises (876.21 vs 786.08 m2/inhabitant)

In Europe, the main impact is on the metropolitan peripheries: light impacted land per capita (LILpc) is higher on the periphery of metropolis than in medium and small cities

In North America, specially in USA, the Sprawl does not concentrate only or mainly in metropolitan peripheries. The dispersion of urbanization is widespread, affecting not only the metropolitan peripheries but also small towns, medium and even large cities

Conclusions

South America and Mexico , the urban sprawl processes are concentrated in metropolitan peripheries. Agglomerations like Mexico DF, Sao Paulo, Buenos Aires, Rio de Janeiro, Bogota, Belo Horizonte, Caracas, Medellin, Porto Alegre, Curitiba, Brasilia, Maracaibo or Cali, are good examples of sprawl in south American metropolitan peripheries

Africa and Asia show similar patterns of land impacted by light. The sprawl doesn't like to be an accused problem in these continents. Although 42 between 200 metropolises in Asia show levels of highly metropolitan peripheral sprawl. And 8 between 38 metropolises have disperse peripheries in Africa

We can conclude that the hypothesis that the peripheries of the metropolitan areas are the main scenery of urban sprawl is confirmed

Thanks for your attention!

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